Bat Conservation Trust

Bat Detector Information Pack

The Basics

There are four types of bat detector:

1. Heterodyne

- Heterodyne detectors are **tuneable** – you select the frequency range to listen to. This makes them the best detectors for immediate identification of bats in the field.
- They work by filtering the inaudible bat sound with an ultrasonic signal from the detector, and producing the audible difference between the two sounds.
- Sounds can be recorded onto a recorder, but recordings **cannot** be used with sound analysis software to generate sonograms as frequency information is not retained.
- They are the **cheapest** of the detectors and are simple to use, making them ideal for beginners.

2. Frequency Division

- Frequency division detectors **detect all frequencies**, so there is no need to tune in to a specific frequency and you don't miss any bats.
- They work by outputting a single sound wave for every ten waves (if divided by 10) in the original call, thereby making the calls audible by reducing the frequencies by a factor of ten, while still enabling you to hear the calls in real-time.
- Sounds can be recorded and analysed with sound analysis software but some information is lost.
- They are generally **low** to **mid-price,** but cheaper versions tend not to retain amplitude information.

3. Time Expansion

- Like frequency division detectors, time expansion detectors **detect all frequencies**.
- They work by digitally recording a short snatch of sound (e.g. 1 second), then playing it back at a slower speed, resulting in very high quality recordings and retention of the same information as the original call. However, recording is not continuous as calls are not detected during the playback period, so snapshots of calls are sampled.
- Sounds can be recorded and used with sound analysis software. They enable a very detailed analysis of the sound and a clearer sonogram when compared to frequency division.
- They are among the most **expensive** of the detectors.

4. Full Spectrum, Real-time Sampling

- Like frequency division and time expansion detectors, full spectrum, real-time sampling detectors **detect all frequencies**.
- They sample at very high rates to capture all signal information and output it in real-time – so you get the detail of call structure as with time expansion, but also the real-time continuous monitoring as with frequency division.
- Sounds can be recorded and used with sound analysis software. They enable a very detailed analysis of the sound and a clearer sonogram when compared to frequency division.
- They are generally more **expensive** than frequency division and time expansion detectors.

Additional note

- Some detectors feature more than one type of sound conversion. For example, some frequency division detectors have a heterodyne mode as well, and some feature three models of sound conversion.

There are a number of factors to consider when choosing a bat detector. These include:

- **Price**
- **Microphone and frequency range**: Microphones determine the sensitivity of the bat detector.
  Piezo – best at mid frequencies (~45kHz), MEMS – mid frequencies (40-60kHz), Electret – lower frequencies (<30kHz), and Capacitance – higher frequencies (>80kHz). You will still be able to detect other frequencies, but the distance from which you can detect them will vary. Detectors with more than

one microphone are best, because they will be sensitive at more than one frequency (e.g. Pettersson D100 overleaf). All European species are detectable within the range 20-120kHz.

- **Bandwidth**: How many kHz either side of your tuned frequency on which you can hear calls (heterodyne). A wider bandwidth reduces the chances of missing species you are not tuned into, while a narrower bandwidth makes it easier to discern the difference between bats calling at similar frequencies.
- **Design**: size, display (LED/LCD), controls on side or top (side-controls easier for single-handed operation).

The following is a guide to some of the detectors that are available on the market at the present time and their main features. It is not intended as a review and prices should only be used as a guide as they may change over time or between suppliers. BCT do not recommend any specific type or model of detector.

Heterodyne Bat Detectors (Summary, in price order)

Model	Approx cost	Microphone (type & no.)	Frequency range	Bandwidth	Batteries	Size (mm)	Speaker	Design features/ other factors
Magenta MkII Kit	£40	unknown	unknown	16kHz (± 8kHz)	1 x 9V (PP3)	145x80x34	Y	Requires soldering & electronics skills & the ability to understand circuit diagrams.
Semafor UF-140	£46	unknown	10-140kHz	unknown	1 x 9V (PP3)	145x60x45	Y	
Semafor UF-220	£55	unknown	10-220kHz	unknown	1 x 9V (PP3)	145x60x45	Y	
Ciel CDB 105 R2 Mono	£60	Electret (1)	18-120kHz	10kHz (± 5kHz)	1 x 9V (PP3)	140x64x31	Y	Integrated LED torch. ('BATZ' model also available-same spec. aimed at children)
Magenta Bat4	£62	Electret (1)	15-130kHz	9kHz (± 4kHz)	4 x AAA	145x80x34	Y	LED torch. Large frequency dial with top illumination. Side controls for single-handed operation. Wrist strap.
Ciel CDB 103 R3 Stereo	£90	Electret (2)	15-130kHz	10kHz (± 5kHz)	1 x 9V (PP3)	170x75x40	Y	LED display. Wrist strap.
Magenta Bat5	£95	Electret (1)	10-130kHz	9kHz (± 4kHz)	4 x AAA	135x72x27	Y	LCD display with backlighting. Inbuilt LED torch. Side controls for single-handed operation. Wrist strap.
Ciel CDB 101 R3 Stereo	£120	Electret (2)	15-130kHz	10kHz (± 5kHz)	1 x 9V (PP3)	170x75x40	N	LCD display. External speaker can be added. Wrist strap.
Ciel CDP 102 R3 Professional Stereo	£150	Electret (2) - external	15-130kHz	13kHz (± 6.5kHz)	External 9-12V DC Source	125x75x40	N	Boxed (for mounting and long-term surveys). Stereo/dual option-can observe 2 frequencies at same time. LCD display.
Mini-3	£155	Electret (1)	15-160kHz	8kHz (± 4kHz)	2 x AA	147x65x40	Y	Large illuminated tuning dial.
Batbox IIID	£156-165	Electret (1)	19-125kHz	16kHz (± 8kHz)	1 x 9V (PP3)	125x69x32	Y	Digital LCD display with backlight. Side controls. Wrist strap.

Model	Approx cost	Microphone (type & no.)	Frequency range	Bandwidth	Batteries	Size (mm)	Speaker	Design features/ other factors
Ciel BM1 Professional Stereo	£170	Electret (2)	15-130kHz	10kHz (±5kHz)	1 x 9V	unknown	N	Clock, temp & humidity sensor. Bat counter. Can categorise frequency into 3 different ranges for counting different spp. Wrist strap.
Batscanner	£187	Electret (1)	15-120kHz	unknown	3 x AAA	120x65x27	Y	Adjusts automatically to detected frequency. LED display.
SSF Bat2	£215	MEMS(1)	15-130kHz	10kHz (±5kHz)	4 x AA	185x65x28	Y	In addition to heterodyne function, also uses frequency division to monitor all frequencies & reports peak frequency.
Pettersson D100	£220	Electret (1) & Piezo (1)	10-120kHz	8kHz (± 4kHz)	1 x 9V (PP3)	113x71x33	Y	Backlit frequency control.
Pettersson D200	£280	Electret (1)	10-120kHz	8kHz (± 4kHz)	1 x 9V (PP3)	119x60x25	Y	Fully backlit LCD display. Side controls – easy to adjust.

Broadband Bat Detectors

Frequency Division Detectors (Summary, in price order)

Model	Approx cost	Division Factor	Microphone	Freq. range	Amplitude retaining	Batteries	Size (mm)	Design features/ other factors
FREQUENCY DIVISION ONLY								
Ciel CDB 205 Mono	£60	10	Electret (1)	18-120kHz	N	1 x 9V (PP3)	140x64x31	LED torch.
Batbox Baton	£80	10	Electret (1)	20-120kHz	Y	1 x 9V (PP3)	165x46x34	Comes with BatScan sound analysis software. Very simple design & easy single-handed operation.
Anabat SD2 and PDA package	£2,090	8,16,32	Capacitance (1)	4-200kHz	N/A	4 x AA (internal) or 12V (external)	155x90x45	Designed for unattended long-term monitoring. CF & GPS compatible. PDA with pre-loaded software. Does not retain amplitude so analysis based largely on call structure and frequency parameters.
FREQUENCY DIVISION AND HETERODYNE								
Ciel CDB 305 R2 Dual	£100	10	Electret (1)	18-120kHz Bandwidth: 10kHz (± 5kHz)	N	1 x 9V (PP3)	140x65x40	Wrist strap.
Ciel CDB 301 R3 Advanced	£200	10	Electret (2)	15-120kHz Bandwidth: 10kHz (± 5kHz)	Y	1 x 9V (PP3)	170x75x35	Backlit LCD display. Separate microphones for each function. Commentary button enabling note-taking. Wrist strap.
Batbox Duet	£255-280	10	Electret (1)	17-125kHz Bandwidth: 16kHz (± 8kHz)	Y	1 x 9V (PP3)	125x69x32	Large LED display & control for single-handed operation. Wrist strap.

Model	Approx cost	Division Factor	Microphone	Freq. range	Amplitude retaining	Batteries	Size (mm)	Design features/ other factors
Pettersson D230	£450	10	Electret (1)	10-120kHz Bandwidth: 8kHz (± 4kHz)	Y	1 x 9V (PP3)	119x60x25	LCD Display. Comment switch. Wrist strap.
U30	£630	10,20,40	unknown	15-200kHz	Y	2 x AA	147x65x40	Miniature 'ultra-low-noise' microphone.
Dodoultra*	unknown	10	unknown	10-125kHz	unknown	2 x AA	147x89x25	Het/frequency shift. In f.s. mode, is a broadband detector & displays peak. F.s. output can be recorded through headphone socket. LCD Display.

*NB this detector uses frequency shift instead of frequency division. The signal is digitally processed to reduce the frequencies by ten with less loss of information.

Time Expansion Detectors (Summary, in price order)

Model	Approx cost	Expansion Factor	Microphone	Freq. range	Batteries	Size (mm)	Design features/ other factors
TIME EXPANSION ONLY							
Tranquility Transect	£470	N/A	Capacitive	10-160kHz	4 x AA	145x95x45	Hands-free (worn around neck). No speaker.
TIME EXPANSION AND HETERODYNE							
Tranquility III	£755	10,32,64	Capacitive	12-160kHz	4 x AA (& internal battery)	155x95x52	LED display. Internal digital recorder. 10.24sec memory.
Pettersson D240x	£1160	10	Advanced Electret (1)	10-120kHz 8kHz (± 4kHz)	1 x 9V (PP3)	119x60x25	LCD Display. Comment switch. Storage time 3.4, 1.7 or 0.1sec. Automatic or manual trigger.
ECO-Mega	£1555	10,32,64	Capacitor	12-160kHz	4 x AA	170x110x40	25.6sec memory. Voice commentary. Time tag-30min intervals. Back-to-back recording.

Time Expansion, Frequency Division, Heterodyne and Full Spectrum Sampling

Model	Approx cost	Frequency/ Expansion Factor	Microphone	Freq. range	Batteries	Size (mm)	Design features/ other factors
Batbox Griffin	£1500-1550	8,10,16 (FD) 16 (TE)	Electret	unknown	AA	unknown	Built in recording. Date, time, temp & light reading levels. Programmable menu-driven function set-up. Can record continuously (up to a max file length of one hour) for full spectrum, real-time sampling.
Pettersson D1000x	£4350 (built to order)	From 1 (original speed) to 30	Capacitance (1)	10-200kHz	Internal batteries or external power supply 6-10V	170x80x35	Built-in recording. 16-bit recording system using compact flashcard as storage. Manual or level-triggering modes. Comments recording mode. TE factor of 1 (for real-time full spectrum sampling) to 30 can be selected.

Full Spectrum, Real-time Bat Recorders (long-term, unattended monitoring)

Model	Approx cost	Microphone	Freq. range	Batteries	Size (mm)	Design features/ other factors
Batcorder	(Email info@ecoobs.com for quote)	Electret (1)	16-150kHz)	4 x AA	unknown	Analyses microphone signal in real-time & discriminates between bat calls & other sound signals. Autonomous long-term monitoring. Independent recording device & software built to co-operate with the hardware.
Song Meter SM2 Ultrasonic 384 kHz Digital Field Recorder	£995	SMX-US	Up to 190kHz	4 x D	unknown	Designed for long-term deployment. Records frequencies up to 192kHz. Sufficient for monitoring nearly all spp. present in Europe. Second channel can be used with conventional SMX-II microphone to record other wildlife at scheduled times, though not simultaneously with ultrasonic monitoring.
Song Meter SM2 Ultrasonic 192kHz Digital Field Recorder	£995	SMX-US	Up to 190kHz	4 x D	unknown	Designed for long-term deployment. Records frequencies up to 96kHz. Widely used in North America. Two channels double monitoring potential & can record simultaneously.
Batlogger	£1535	Electret (1)	10-150kHz	3.7V 4600mAh Li-Ion 12 V DC charger	155x80x38	Manual or automatic recording. Integrated GPS. Coordinates & temperature recorded with each sound recording. **Free** BatExplorer analysis software.
Pettersson D500x	£1795	Electret (1)	N/A Sampling rates: 44.1, 300, and 500kHz (optim. for 500kHz)	4 x AA or external power supply	184x172x52	Detects & records ultrasound in real-time. Aimed for long-term unattended recording of bat calls. 4 slots for CompactFlash memory cards with total capacity of 128GB. Triggering system allowing device to start recording as sound is detected.

Manufacturers and suppliers (details correct at time of going to print)

Alana Ecology Ltd: www.alanaecology.com The Old Primary School, Church Street, Bishop's Castle, Shropshire, SY9 5AE Tel: +44 (0)1588 630173 Email: sales@alanaecology.com.

Anabat SD1
Batbox: III-D, Baton, Duet, Griffin
Magenta: MKII Kit, Bat4, Bat5
Mini-3
Pettersson D100, D200, D230, D240x, D500x, D1000x

Batbox Ltd: www.batbox.com 2A Chanctonfold, Horsham Road, Steyning, West Sussex, BN44 3AA
Tel: 01903:816298 Email: info@batbox.com
Batbox III-D, Baton, Duet

Bat Management: www.batmanagement.com **US-based** – email for a UK quote sales@batmanagement.com
Pettersson D200, D500x (only available here), D1000x

Bat Planet: www.batplanet.co.uk C/o Yarwood Ltd, Treefield Industrial Estate, Gelderd Road, Leeds LS27 7JU
Email: sales@batplanet.co.uk
Full range of Ciel detectors (not including CDP 302), Belfry bat detector

Bioquip: www.bioquip.net
Batbox III-D and Duet
Full range of Ciel detectors (not including CDP 302)

Courtpan: http://courtpan.gnxt.net 3 Suffolk Street, Cheltenham, GL50 2DH Tel: 01242 570123
Email: courtpan@gxn.co.uk

Tranquillity Transect, Tranquility III, ECO-Mega

Dodotronic: www.dodotronic.com Via de Gasperi 5, 00040, Castel Gandolfo, RM, Italy
Email: info@dodotronic.com
Dodoultra

EcoObs: www.ecoobs.com Contact via online contact form http://www.ecoobs.com/cnt-contact.html
Batcorder

Elekon AG: http://www.elekon.ch/en/batlogger/products/ Cheerstrasse 16, CH-6014, Lucerne, Switzerland
Tel: +41 41 250 40 40 Email: mail@elekon.ch
Batlogger, Batscanner

Green witch: www.green-witch.com (search for bat detectors) Tel: 01954 211 288.
Batbox: III-D, Baton, Duet, Griffin (available to pre-order)

Magenta Electronics Ltd: www.magenta2000.co.uk 135 Hunter Street, Burton on Trent, Staffs, DE14 2ST
Tel: 01283 565435 Email: sales@magenta2000.co.uk
Magenta: MKII Kit, Bat4, Bat5

NHBS: http://www.nhbs.com/ 2-3 Wills Road, Totnes, Devon, TQ9 5XN Tel: 01803 865913
Email: customer.services@nhbs.co.uk.
A range of detectors including SSF Bat2

Pettersson Elektronik AB: www.batsound.com **Sweden-based** – email for a UK quote info@batsound.com
Full range of Pettersson detectors (except D500x)

Semafor: http://www.semafor.co.uk/bat-detector.html Email: enquiries@semafor.co.uk (for a catalogue)
Semafor UF-140, UF-220

Titley Electronics: www.titley.com.au **Australia-based** – can be shipped to UK. Email: info@titley.com.au
Anabat SD1 and SD2

Ultra Sound Advice: http://www.ultrasoundadvice.co.uk 27 Merton Hall Road, Wimbledon, London SW19 3PR Tel: 020 8287 4614 Email: sales@soundadvice.co.uk
Mini3 Detector, U30 Detector

Sound Analysis Software

A selection of software packages for analysing bat echolocation calls recorded using a broadband bat detector (time expansion or frequency division) are listed here (with some of the more frequently used ones at the start). We do not recommend specific packages, but BCT training courses in sound analysis cover the following: BatSound, BatScan, Wavesurfer, and TF32.

- **Adobe Audition v 3.0.** is a substantial package that calculates all the start/end/peak frequencies of a pulse for you and allows you manipulation sounds. It can also convert batches of mp3 or other formats to WAV format quickly. You can also listen to heterodyne separate from the FD channel on Duet recordings. Audition v 3.0 is available as a **30 day try-out** and the full package is $350. Web site http://www.adobe.com/uk/products/audition/

- **Avisoft** at www.avisoft.com offers a **free download** of a minimal program called SAS Lab Lite (5.7 MB) for very basic editing and generation of spectrograms. The full Avisoft has a whole range of functions although it takes time to learn how to use them all.

- **Bat Scan,** available from www.batbox.com,comes with a selection of sample files so that you can compare your own recordings. It costs £17 (plus VAT and delivery) and is a simplified version of Spectrogram. In general it is faster and easier to use than BatSound, but does not have all of the functions. It is designed to be used with frequency division recordings. Follow-up service and advice is good. It is also available from Alana Ecology www.alanaecology.com at £30 (including VAT).

- **BatSound** is the original software developed by Pettersson especially for use with ultrasonic bat calls and is generally considered to be the industry standard. It is available directly from Pettersson (http://www.batsound.com/?p=34), and also from Alana Ecology (www.alanaecology.com). Costs start at around £275 for a single user licence, and more for multiple licences. BatSound has a nice big window for sonograms and an easy to use toolbar with shortcut buttons that operate on a mouse click for common functions. It also has lot of additional functions and newer versions have improved settings. The help files are generally well-structured and easy to use. Newer versions also allow you to import mp3 files directly into BatSound and to manage recordings from the D500x. You can download an **evaluation version of the latest software for free** from the Pettersson website.

- **TF32** is a **free** programme designed for speech analysis. A user manual is available from http://www.medsch.wisc.edu/~milenkvc/tools.html and a sound analysis instruction booklet from BCT.

- **Wavesurfer** is another completely **free** program available from http://www.speech.kth.se/wavesurfer. This was developed for speech analysis and you need to establish your own spectrogram parameters and save them. Therefore, you need to know a little about the terminology (FFTs, etc.) or you can look at the **ibats** website for instructions written by Dr Jon Russ (http://www.ibats.org.uk/page.aspx?tabid=256.

- **Cool Edit Pro 2.1**, produced by Syntrillium, has been taken over and is now sold as Adobe Audition. However, the old version is available as a **free download** from http://www.softpedia.com/progDownload/Cool-Edit-Pro-Download-2076.html (18.20MB) for a **21-day free trial** in which you can analyse 10ms calls. The spectrogram and oscillogram cannot be viewed simultaneously.

  There are also a number of programs that have been developed in the USA and/or are designed to work with Apple Macs, although most of these have not been tested.

- **Sonobat v 2.5.5** is a program developed in the USA. It includes an auto-trigger recording function developed especially for the D240x set up to trigger automatically and allowing remote recording to a digital recorder. It allows you to look at reference calls in the same window next to a call that you are trying to identify. Reference calls are automatically adjusted to match the time and frequency scale of the one you are looking at. Analysis functions are plentiful including definition of low/high frequencies, bandwidth, duration, heel, slope, characteristic frequencies, harmonics and automatic

calculation of the inter-pulse interval. The program costs US$320. There is a **free downloadable demo** of v2.4 for Mac and PC (http://www.sonobat.com).

- **bcAnalyze 1.0** is a programme designed to work with real-time recordings of bat calls. To be used with recordings from the Batcorder system (http://www.ecoobs.com/cnt-bcAnalyze.html). A call finding algorithm quickly finds calls within the recording. A license costs €140 (+VAT) and runs for 30 days in trial mode. System requirement is a Mac running Mac OS X 10.5.

- The Bioacoustics Research Programme at **Cornell Laboratory of Ornithology** developed a well-respected sound program called **Canary** some time ago. It is **free** to download, but unfortunately only runs on Mackintosh (http://www.birds.cornell.edu/brp/software/canary-information). The user manual includes background information about how spectrograms are created and analysed. If you are willing to delve into some physics, it can help you to use other sound analysis programs more effectively. Relevant sections (available from http://www.birds.cornell.edu/brp/software) are Appendix A: Digital Representation of Sound and Appendix B: A Biologists Introduction to Spectrum Analysis.

- The new sound analysis software from **Cornell University**, called **'Raven,'** is available from http://www.birds.cornell.edu/brp/raven/Raven.html. There are two options – Raven v 1.4, and Raven Lite which is **free**. The full version is able to display any number of sound files simultaneously, with each file in its own window. It has other features that allow you to easily measure, compare and edit parts of different sequences and sounds. The Raven Lite version has the ability to view only a single spectrogram at one time. Both versions are available for Mac OSX or PC. The full version is US $400 ($100/year for students).